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ABSTRACT

Data were collected in a teacher effectiveness study on the interaction of teachers and first grade students while the students participated in reading groups within intact classes. Eighteen teacher behavior variables drawn from the data were then related to student achievement using three units of analysis: class means, reading group means within classes, and student scores within reading groups. The results were then compared across the three sets of analyses. It was found that the pattern of results differed depending upon the unit used in the analyses. The relationships of teacher behaviors to student achievement were frequently inconsistent across within-class and between-class analyses. Relationships that occurred at the class level of analysis did not always occur within classes, and relationships that occurred within classes at the student-within-reading-group level of analysis frequently did not occur at the reading-group-within-class or class levels of analysis. It was concluded that a combination of both within-class analyses and between-class analyses provided a better understanding of the relationship of teacher-student interactions to student achievement than did either within-class or between-class analysis alone. (Author/FL)

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Levels of Analysis in Teacher Effectiveness Research

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Footnote to Authors

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Abstract

Data were collected in a teacher effectiveness study on the interaction of teachers and first-grade students while the students participated in reading groups within intact classrooms. In the present investigation, 18 of those previously recorded teacher behavior variables were related to student achievement using three units of analysis: class means, reading group means within classes, and student scores within reading groups. Results were then compared across the three sets of analyses. It was found that the pattern of results differed depending upon the unit used in the analyses. Particularly striking was the large number of significant results at the student within reading group level of analysis. Apparently, some variables took on different meanings in the context of a small reading group, implying that students were very much aware of and affected by their learning environment. It was concluded that a combination of both within-class analyses and between-class analyses provides a better understanding of the relationship of teacher-student interactions to student achievement than either within-class or between-class analyses alone.

Levels of Analysis in Teacher Effectiveness Research

Teacher effectiveness research is concerned with determining relationships between student learning and teacher behaviors that occur during the process of instruction. Briefly, teacher effectiveness research involves observing and recording events which occur in the classroom over a specified period of time. Student achievement is measured before and after the period of observation, and increases in student achievement which occur over the observation period are then related to the occurrence of particular teacher behaviors. The goal of this type of research is to identify teacher behaviors which promote student learning in the classroom.

Although in many teacher effectiveness studies data are collected on individual students, class means are typically the unit of analysis. This avoids the methodological problem of nonindependence which would arise if student scores were pooled without regard to class membership. Recently, however, this practice has aroused some criticism. According to Cronbach (Note 1), class level analyses can be misleading, as relationships obtained at the class level of analysis may not occur within classes. For example, a positive relationship between praise and achievement at the class level may indicate that classes which receive more praise than other classes achieve more, but it does not necessarily follow that students <u>within</u> a class who receive more praise than their peers will achieve more. If only class level relationships are examined, readers are likely to assume that the reported relationships hold within as well as between classes.

One reason relationships may differ within and between classes is that classroom environment may have a differential effect upon the impact

of certain teacher behaviors--an effect which is lost when scores on teacher behavior variables are aggregated to class means. Consequently, the meaning of teacher behavior variables may differ somewhat depending upon whether the variables are class means or individual pupil scores.

There are many influences operating within classes which may affect relationships between teacher behaivors and student achievement, causing these relationships to differ from class level relationships. One potential within-class influence is differential treatment of students by the teacher. Teacher expectations research (reviewed by Brophy and Good, 1974, and Braun, 1976) has shown that teachers often do respond differently to the students in their classes, and that different treatment may serve to convey the teacher's expectations for success. A "self-fulfilling prophecy" may result if differential teacher behavior, based on expectations, leads to student behaviors or outcomes that are in line with the expectation. For example, if a teacher expects that a student will not be able to answer difficult questions, the teacher may ask the student fewer challenging questions and may push him less hard than other students to practice important skills. The prophecy becomes self-fulfilled if the student achieves less because of fewer opportunities and less encouragement. That is, students within a class may achieve more or less relative to one another, depending at least partly on the teacher's different treatment of them in ways that may influence achievement.

Another potential source of influence on within-class relationships involves social patterns within the classroom (students' influence on one another). Weinstein and Middlestadt (in press) found that students have fairly consistent perceptions of high and low achievers, and associate differing teacher behaviors with the two groups. This suggests that

students' perceptions of others in the class may be related to the teacher's different treatment of high and low achievers. Weinstein and Middlestadt also suggest that because classrooms are social settings, other students may contribute a great deal to an individual's perception of himself or herself as a learner, which in turn will influence effort and achievement.

Given such potential within-class influences on the interactions and achievement of individual students, researchers of teacher effectiveness should consider analyses of both between-class and within-class relationships of teachers' behaviors to student outcomes. One teacher effectiveness study which provides an excellent data base for examining results at different levels of analysis is the First-grade Reading Group Study by Anderson, Evertson, and Brophy (1979). For a complete review of this study, the reader is referred to the technical report (Note 2). In this study, the interactions of students and teachers were observed and recorded while students participated in reading groups within intact classrooms. Hence, there are three potential analysis units: students, reading groups, and classes.

In the present investigation, data from the First-grade Reading Group Study were analyzed at three different levels: 1) Class means were analyzed; 2) reading group means were analyzed within classes; and 3) student scores were analyzed within reading groups. Each of these three analyses addresses a somewhat different question. Class level analyses determine whether class means on the teacher behavior are related to mean class achievement. Because class means are involved, relationships obtained in these analyses are relationships between absolute (as opposed to relative) amounts of the behavior. In contrast, reading-group-within-

class analyses determine whether, within classes, reading group means are related to achievement. Because reading group means are compared within classes, relationships obtained in these analyses are relative. That is, a positive relationship indicates that reading groups which have received a higher amount of the teacher behavior relative to other groups within the same class will achieve more--regardless of the actual amount of the teacher behavior received by that higher group. Similarly, individual-within-reading-group analyses reveal whether student scores within reading groups are related to student achievement. Because student scores are compared within reading groups, relationships obtained in these analyses are also relative, i.e., a positive relationship indicates that students who receive more of that teacher behavior relative to other students in their reading groups will achieve more.

Method

Overview

The First-grade Reading Group Study was an experimental study designed to test the effectiveness of several principles of small group instruction in producing student achievement (Brophy, Anderson, Greenhalgh, Ogden, & Selig, Note 3). Teachers were divided into three groups: 1) The treatment-observed group was composed of ten teachers who were given instruction in the use of these principles and were observed interacting with their students in the classroom. 2) The control-observed group was composed of ten teachers who had no contact with the instructional principles but were observed in the classroom. 3) The treatment-unobserved group was composed of seven teachers who received instruction in the use of the principles but were not observed. Thus, observation data were

available on the ten teachers in the treatment-observed group and the ten teachers in the control-observed group.

However, this sample of 20 teachers had to be reduced considerably in order to obtain a consistent set of data for the analyses presented here. It was necessary to have a data set that contained observation scores recorded for students while they participated in a single reading group within a single intact classroom. Hence, the results presented in this investigation are based on a subset of the original sample and therefore differ to some degree from the results based on the full sample presented by Anderson, Evertson, and Brophy (1979). Students with pretest and observation data but no posttest data were eliminated, as were students with posttest and observation data but no pretest. Reading groups were also eliminated if they had fewer than six observations. Any reading groups with less than four students were dropped, and finally, any classes with less than two reading groups were dropped. The end result was a set of data in which every student participated in a single reading group within a single classroom.

Subjects

All data were collected in six middle-SES schools serving a predominantly white population in Austin, Texas. The final data set consisted of 15 classes, 41 reading groups, and 288 students. Of the 15 classes, nine were treatment classes and six were control classes. The number of reading groups in each class varied from two to four with a mean of 2.7 groups per class. The number of students in each reading group varied from four to 13 with a mean of seven students per reading group.

Instruments

Classroom observations were recorded on a low inference coding instrument (Brophy, Mahaffey, Greenhalgh, Ogden, & Selig, Note 4) developed specifically for the First-grade Reading Group Study (Anderson, et al., Note 2). Only student-teacher interactions initiated by the teacher during reading group instruction were recorded on the coding sheets.

The pretest given at the beginning of the school year was the Metropolitan Readiness Test, which consists of six subscales: Word Meaning, Listening, Matching, Alphabet, Numbers, and Copying. A Total Readiness score was computed from these six subscales to be used in all analyses as the pretest measure. The posttest given at the end of the school year included the Metropolitan Achievement Test, Level I, reading subtests, Word Knowledge and Reading. These were summed to create a Total Reading score, which was used as the posttest measure of student achievement in all analyses in this study.

Dependent Variables

The particular variables used in the present analyses were chosen from a much larger number of measures collected in the First-grade Reading Group Study to represent the four major components of an academic interaction between the teacher and an individual student: The teacher selects a respondent, then asks a question, the student answers, and the teacher responds to the answer. Each of the variables is described below:

1. Method by which teacher selected students to answer questions or to read: ordered turns (teacher calls on students in some order based on seating arrangements, so that it is obvious to a student when he will be chosen), preselections (teacher calls on a student before asking a

question), volunteer selections, nonvolunteer selections, or call outs (students call out the answer out of turn);

2. Type of teacher question: reading or nonreading;

3. Type of student answer: student answers correctly, student answers incorrectly, student says he does not know the answer, or student fails to respond;

4. Correct answers followed by no feedback from the teacher;

5. Correct answers followed by emphasis feedback (i.e., the teacher does something to insure that the answer just given by a student is heard by other students);

6. Correct answers followed by teacher praise;

7. Correct answers followed by the teacher asking the student a new question;

8. Incorrect answers followed by teacher criticism;

9. Incorrect answers followed by sustaining feedback (i.e., the teacher requires the student to continue responding by providing a clue, or repeating the question);

10. Incorrect answers followed by terminating feedback (i.e., the teacher ends the student's response opportunity by getting the answer from another student or giving the answer herself).

Data Collection

Students in the participating classrooms were given the Metropolitan Reading Readiness Test at the beginning of the school year by their classroom teachers. Classroom observations began in November and each of the observed classrooms (nine treatment-observed and six control-observed classrooms) was visited 15 to 20 times, or approximately once a week, by an observer for the remainder of the school year. At the end of the school

year, observers administered the Metropolitan Reading Achievement subtests to classes with the aid of classroom teachers.

Four observers were trained in the use of the observational coding system. Since these observers were involved in the development of the coding system, they were quite familiar with it when coding actually began. Training consisted of each possible pair of observers coding together in an actual classroom, followed by discussion of the coding process to increase similarity in coding methods. Every observer coded with every other observer until 80% agreement was reached on each major section of the coding system. Each of the 20 teachers was seen by two observers who alternated visits to her classroom.

Data Analysis and Results

Three sets of regression models were evaluated for each variable. In all models, reading readiness scores were used as a covariable and reading achievement scores were used as the posttest. The first set of models contained class means as the unit of analysis. Predictors were the teacher behavior variable and the interaction (product) of the teacher behavior variable with readiness. The proportion of variance accounted for by each of these predictors is shown in Table 1.

The second set of models contained reading group means as the unit of analysis. Predictors were the teacher behavior variable, the interaction of the teacher behavior variable with readiness, and a set of binary vectors indicating class membership. Inclusion of the binary vectors, in effect, caused the reading group scores to be analyzed within classes. The proportion of variance accounted for by the teacher behavior and the interaction of that behavior with readiness when class membership vectors remained in the model is shown in Table 2.

The third set of models contained student scores as the unit of analysis. Predictors were the teacher behavior variable, the interaction of the teacher behavior variable with readiness, and a set of binary vectors denoting reading group membership. Inclusion of the binary group membership vectors, in effect, caused the students' scores to be analyzed within reading groups. The proportion of variance accounted for by teacher behavior and by the interaction of teacher behavior with readiness while the binary vectors remained in the model is shown in Table 3.

A comparison of results across all three levels of analysis shows that relationships between teacher behaviors and student achievement are generally not the same when different units (students within reading groups, reading groups within classes, and classes) are used in the analyses. For example, at the student-within-reading-group level of analysis, 11 out of 19 variables were significantly related to achievement; at the reading-group-within-class level, three variables were significantly related to achievement; and at the class level four variables were significantly related to achievement.

The greater number of significant relationships at the student-within-reading-group level of analysis may be due, at least partially, to the increase in power at this level, as the degrees of freedom have increased from 11 for class level analyses to 23 for reading-group-within-class analyses to 244 for student-within-reading-group analyses. However, beyond approximately 30 degrees of freedom, the increase in power which accompanies an increase in the degrees of freedom levels off (Myers, 1972). Therefore, a three-fold increase in significant results at the student-within-reading-group level of analyses cannot be wholly attributed to increases in power. Also, if differences in significant relationships at

the different levels of analysis were to be attributed solely to power increases, one would expect considerably more significant results at the reading group level of analysis than at the class level. Yet in this study, more significant relationships were obtained at the class level of analysis than at the reading-group-within-class level.

Discussion

There were three different patterns of results which emerged from the multiple analyses of the 18 teacher behavior variables. Consideration of each of these patterns as a whole reveals more information about the variables than consideration of results for each level of analysis separately. Therefore, these three patterns will be discussed below.

For two variables, "students answer teacher questions correctly," and "students fail to respond to teacher question," significant results were obtained at all levels of analysis: individual-within-reading-group, reading-group-within-class, and class. Because these relationships were consistent across all three levels of analysis, they can be interpreted in a very straightforward manner. Within the range of responses observed in these data, the greater the amount of a behavior, the better (or worse) a student achieved. Accordingly, one would expect a significant relationship both within classes and between classes. For example, classes with a higher percentage of correct answers would achieve more than classes with a lower percentage. Similarly, within classes students or reading groups with a higher percentage of correct answers would achieve more than students or groups with a lower percentage of correct answers.

The second pattern to be discussed involves nine teacher behavior

variables significantly related to achievement only at the individual-within-reading-group level of analysis. These variables include:

student calling out answers to teacher questions,

teacher asking reading questions,

teacher asking nonreading questions,

student responding incorrectly to teacher questions,

student responding to teacher questions with "don't know,"

teacher praising student responses,

teacher criticizing student responses,

teacher terminating a student's opportunity to respond, and

teacher sustaining a student's response opportunity.

The presence of a relationship only at the individual-within-reading-group level of analysis suggests that within-group comparisons are responsible for the significant relationship. In other words, the absolute amount of a teacher behavior a student receives is not related to achievement (which may be why the relationship does not show up at the class level of analysis), but the relative standing of the student within his reading group is related to achievement. For example, teacher criticism of student responses was significantly negatively related to achievement at the student-within-reading-group level of analysis, but was unrelated to achievement at the other two analysis levels. This indicates that some type of group context effect may be responsible for the significant relationship at the individual level. In other words, it does not matter how much criticism a student receives but rather how much he receives relative to his peers in the same reading group. Possibly, students who receive more criticism develop negative feelings, as they know their performance does not compare favorably with that of their peers.

Significance only at the student-within-reading-group level of analysis is probably the most important finding in this study. Its implications are particularly apparent when one considers the large number of contradictory studies reported in the last decade concerning the effect of praise and criticism on student achievement. If, as this study indicates, these variables effect student achievement only because they indicate where a student stands relative to his peers, researchers may be able to resolve some of these previous inconsistencies by considering group context.

The third pattern involves one teacher behavior variable, "teacher selects a nonvolunteer to respond," which was significant at the class and reading-group-within-class levels of analysis but was not significant at the student-within-reading-group level of analysis. In this case, it was hypothesized that the nature of the variable was responsible for the absence of a relationship at the student-within-reading-group level of analysis. Use of nonvolunteer selection with a reading group was likely to have a similar effect on all students in the group, regardless of who was selected as a nonvolunteer. In other words, nonvolunteer selection is a process by which any student in the reading group could be called on at any time. Hence, all students within a reading group in which the teacher was using nonvolunteer selection would be similarly affected.

In conclusion, the relationships of teacher behaviors to student achievement were frequently inconsistent across within-class and between-class analyses. Relationships which occurred at the class level of analysis did not always occur within classes and relationships which occurred within classes at the student-within-reading-group level of analysis frequently did not occur at the reading-group-within-class or class levels of analysis. Furthermore, the pattern of relationships at the

different levels of analysis revealed information which was helpful in constructing a meaningful interpretation for certain teacher behavior variables. Therefore, it appears that a combination of both within-class and between-class analyses provides a more comprehensive picture of the relationship of student-teacher interactions to student achievement than either within-class or between-class analyses alone. Accordingly, teacher effectiveness researchers should be encouraged to analyze their data within classes as well as at the more traditional class level.

Reference Notes

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Table 1

Results from Class-Level Analyses

Item	$\bar{x}$	SD	Difference in R^2 Interaction	p	Difference in R^2 Simple Effect	p	Beta[a]
1. Total initial selections that were ordered	.54	.29	.0402	ns	.0093	ns	-.0094
2. Total initial selections that were preselections	.08	.10	.0129	ns	.0269	ns	.1641
3. Total initial selections that were nonvolunteer	.18	.12	.0977	.04	.0002	ns	.0126
4. Total initial selections that were volunteer	.14	.11	.0102	ns	.0028	ns	.0566
5. Total initial selections that were call outs	.06	.04	.0014	ns	.0028	ns	.0552
6. Total ROs* that were reading questions	.69	.14	.0214	ns	.0002	ns	-.0194
7. Total ROs that were nonreading questions	.30	.14	.0212	ns	.0003	ns	.0211
8. Total ROs with correct answers	.71	.06	.0001	ns	.1054	.02	.3286
9. Total ROs with incorrect answers	.22	.05	.0065	ns	.0226	ns	-.1515
10. Total ROs with don't know answers	.02	.01	.0116	ns	.0033	ns	-.0700
11. Total ROs with no response answers	.12	.04	.0000	ns	.1383	< .01	-.3745

Table 1-Continued

Item	$\bar{x}$	SD	Difference in R^2 Interaction	p	Difference in R^2 Simple Effect	p	Beta[a]
12. Correct answers with no feedback	.08	.08	.0411	ns	.0329	ns	.1876
13. Correct answers with emphasis feedback	.37	.12	.0000	ns	.0576	ns	-.2458
14. Correct answers with praise feedback	.10	.06	.0043	ns	.0464	ns	-.2304
15. Correct answers with new question feedback	.19	.04	.0333	ns	.1013	.03	.3227
16. Incorrect answers with criticism feedback	.02	.01	.0120	ns	.0178	ns	.1349
17. Total incorrect answers with terminating feedback	.49	.14	.0014	ns	.0332	ns	-.1900
18. Total incorrect answers with sustaining feedback	.48	.13	.0009	ns	.0237	ns	.1588

[a]Refers to the standard partial regression coefficient for the teacher behavior. This coefficient indicates how many units the criterion increases for every unit increase in the teacher behavior, with the effect of all other variables in the equation held constant. The sign on this coefficient indicates the direction of the relationship.

*ROs = response opportunities

Table 2

Results from Reading Group Within Class Analyses

Item	$\bar{x}$	SD	Difference in R^2 Interaction	p	Difference in R^2 Simple Effect	p	Beta[a]
1. Total initial selections that were ordered	.53	.07	.0057	ns	.0136	ns	.7600
2. Total initial selections that were preselections	.09	.02	.0101	ns	.0025	ns	.2651
3. Total initial selections that were nonvolunteer	.18	.03	.0024	ns	.0154	< .05	-.5651
4. Total initial selections that were volunteer	.14	.03	.0023	ns	.0065	ns	-.3443
5. Total initial selections that were call outs	.06	.02	.0017	ns	.0010	ns	-.0584
6. Total ROs* that were reading questions	.68	.06	.0084	ns	.0006	ns	-.0703
7. Total ROs that were nonreading questions	.30	.06	.0088	ns	.0009	ns	.0825
8. Total ROs with correct answers	.72	.06	.0001	ns	.0201	.02	.2442
9. Total ROs with incorrect answers	.21	.05	.0001	ns	.0102	ns	-.1750
10. Total ROs with don't know answers	.01	.01	.0075	ns	.0007	ns	-.0430
11. Total ROs with no response answers	.12	.03	.0011	ns	.0169	.04	-.2575

Table 2-Continued

Item	$\bar{x}$	SD	Difference in R^2 Interaction	p	Difference in R^2 Simple Effect	p	Beta[a]
12. Correct answers with no feedback	.08	.04	.0007	ns	.0002	ns	-.0256
13. Correct answers with emphasis feedback	.36	.07	.0043	ns	.0000	ns	-.0096
14. Correct answers with praise feedback	.10	.05	.0083	ns	.0005	ns	-.0413
15. Correct answers with new question feedback	.19	.06	.0117	ns	.0009	ns	-.0358
16. Incorrect answers with criticism feedback	.02	.02	.0135	ns	.0002	ns	.0188
17. Total incorrect answers with terminating feedback	.50	.06	.0012	ns	.0001	ns	-.0198
18. Total incorrect answers with sustaining feedback	.46	.06	.0004	ns	.0017	ns	-.0901

Note. Means were calculated for reading groups within each class and then averaged across classes. Standard deviations of reading group means were also computed for each class and then these standard deviations were averaged across classes.

[a]Beta refers to the standard partial regression coefficient for the teacher behavior. This coefficient indicates how may units the criterion increases for every unit increase in the teacher behavior, with the effect of all other variables in the equation held constant. The sign on this coefficient indicates the direction of the relationship.

*ROs = Response opportunities

Table 3

Results from Student-Within-Reading Group Analyses

Item	$\bar{x}$	SD	Difference in R^2 Interaction	p	Difference in R^2 Simple Effect	p	Beta[a]
1. Total initial selections that were that were ordered	.53	.07	.0016	ns	.0005	ns	.0842
2. Total initial selections that were preselection	.09	.03	.0133	ns	.0000	ns	.0133
3. Total initial selections that were nonvolunteer	.19	.06	.0039	.ns	.0000	ns	-.0040
4. Total initial selections that were volunteer	.13	.05	.0021	ns	.0018	ns	.0830
5. Total initial selections that were call outs	.06	.05	.0000	ns	.0070	< .01	-.1136
6. Total ROs* that were reading questions	.69	.06	.0012	ns	.0066	.01	.1718
7. Total ROs that were nonreading questions	.30	.06	.0015	ns	.0050	.03	.1477
8. Total ROs with correct answers	.72	.10	.0001	ns	.0737	< .001	.3312
9. Total ROs with incorrect answers	.21	.08	.0000	ns	.0493	< .001	-.2719
10. Total ROs with don't know answers	.01	.01	.0000	ns	.0163	< .001	-.1597
11. Total ROs with no response answers	.12	.07	.0000	ns	.0353	< .001	-.2245

Table 3-Continued

Item	$\bar{x}$	SD	Difference in R^2 Interaction	p	Difference in R^2 Simple Effect	p	Beta[a]
12. Correct answers with no feedback	.07	.03	.0015	ns	.0001	ns	.0216
13. Correct answers with emphasis feedback	.37	.08	.0006	ns	.0033	ns	.1072
14. Correct answers with praise feedback	.10	.05	.0074	< .01	.0004	ns	-.0374
15. Correct answers with new question feedback	.18	.06	.0013	ns	.0009	ns	-.0425
16. Incorrect answers with criticism feedback	.02	.03	.0007	ns	.0048	.03	-.0849
17. Total incorrect answers with terminating feedback	.49	.15	.0021	ns	.0147	< .001	-.1527
18. Total incorrect answers with sustaining feedback	.48	.14	.0014	ns	.0081	< .01	.1147

Note. Means were calculated for each student and then averaged across reading groups and classes. Standard deviations of reading group means were also computed for each class and then averaged across reading groups and classes.

[a]Beta refers to the standard partial regression coefficient for the teacher behavior. This coefficient indicates how may units the criterion increases for every unit increase in the teacher behavior, with the effect of all other variables in the equation held constant. The sign on this coefficient indicates the direction of the relationship.

*ROs = Response opportunities